the upper surface of this commissure, just as happens also in the Metatheria; and yet, high up near the dorsal margin of the hemisphere, there is an undoubted corpus callosum. The shape of this body is no less peculiar than its extraordinary position. It is exceedingly large and thin, and exhibits a state of affairs which is almost unknown beyond the limits of the Primates. It is, moreover, provided with a plump splenium and a long hook-like genu ending in a sharp rostrum.

Both in shape, size, and position this corpus callosum (*c.c.*) is as unlike the primitive generalized condition of the corpus callosum, such as is found in *Erinaceus*, as it is possible to imagine.

The most primitive form of corpus callosum is exhibited in the brain of many small Bats such as *Nyctophilus* *; but whether as the persistence of the original condition or as a secondary reversion to it, does not especially concern us now. In *Erinaceus* † the evolution of the corpus callosum is carried only slightly further.

In many small Insectivores like *Hemicentetes*, *Oryzoryctes* ‡, and others, a similar state of affairs is found. In *Gymnura* ‡ and *Talpa* the corpus callosum is larger, but the condition is essentially the same. In *Chrysochloris* ‡ there is an extraordinary elongation of the corpus callosum, such as we do not find in other small Insectivores, nor in the Edentate *Chlamydophorus*, which in this respect resembles *Erinaceus* much more closely than does the Golden Mole.

But even in *Chrysochloris* the corpus callosum is not nearly so long as it is in *Macroscelides*, while in the former it has the primitive straight form. Thus while *Macroscelides* has the most specialized form of corpus callosum of all Insectivores, its psalterium retains the peculiar crescentic form found elsewhere only in the Marsupialia.

In all other mammals with a corpus callosum the growth of the latter modifies the shape of the psalterium by pulling it

* *Cf.* "The Origin of the Corpus Callosum," Trans. Linn. Soc., ser. II. Zool. vol. vii. pt. 3 (1897).

† *Cf.* "The Relation of the Fornix to the Margin of the Cerebral Cortex," Journ. Anat. & Phys. vol. xxxii. 1898, p. 45.

‡ For the brain of *Gymnura* I am indebted to Dr. Charles Hose; for that of *Hemicentetes* and *Oryzoryctes* to Dr. Forsyth Major; and for that of *Chrysochloris* to Dr. Broom.

backward and stretching it. This has not happened in *Macroscelides*, and unfortunately I am unable to state what connection really exists between the corpus callosum and psalterium. In an examination of the mesial surface of the hemisphere with a lens, I was unable to find any connecting-link between the two commissures; nor did the histological investigation yield any more satisfactory result.

And yet from what we know of the evolution of the corpus callosum, we can safely predict that when better material is available (which Dr. Broom assures me will soon be the case) a bridge will be found in the position marked *x* in the diagram (fig. 2) joining the anterior limb of the psalterium to the under-leaf of the splenium. This bridge may not contain any nerve-fibres, and may thus realize a condition which we find in the Hapalidæ*, but there must at least be a narrow lamina of neuroglia.

In the interval (*y*) between the corpus callosum and the psalterium there is a subsplenial hippocampal flexure of the usual structure, though of an unusually great size. I have traced the course of this flexure in a series of sections, and have been able to establish the fact that it does not differ essentially from that of *Erinaceus*.

As soon as I get better material I hope to publish full details of the minute structure of this interesting brain, and to compare it in detail with that of *Erinaceus*, *Gymnura*, *Talpa*, *Chrysochloris*, *Hemicentetes*, *Oryzoryctes*, and *Galeopithecus*.

I have written enough, however, to show that Parker's remark concerning the skeleton, that "we have a curious mixture of Marsupial (Metatherian) and Eutherian characters," might with equal truth be applied to the brain.

* *Cf.* "The Relation of the Fornix," Journ. Anat. & Phys. vol. xxxii. 1898, p. 52.

On the Early Condition of the Shoulder-Girdle in the Polyprotodont Marsupials *Dasyurus* and *Perameles*.

By Robert Broom, M.D., C.M., B.Sc. (Communicated by Prof. G. B. Howes, F.R.S., Sec. L.S.)

[Read 1st May, 1902.]

(Plate 41.)

In 1897 I discovered that the Common Phalanger (*Trichosurus vulpecula*) has at birth a well-developed coracoid, which is firmly attached to the sternum, and I recorded the fact at the time in a short note in the 'Journal of Anatomy and Physiology' (1).

In 1899, Sir William Turner communicated to the Royal Society of Edinburgh for me a paper (2) dealing at length with the development of the shoulder-girdle in *Trichosurus vulpecula*, and containing some observations on the early condition of the girdle in *Pseudochirus* and *Petrogale*. Since then, through the kindness of my friends Prof. J. T. Wilson and Mr. J. P. Hill, of Sydney, I have been enabled to study one or two stages in the early development of the shoulder-girdle of two of the Polyprotodont genera—*Dasyurus* and *Perameles*.

Dasyurus viverrinus (*Early Stage*). (Pl. 41. figs. 1 & 2.)

The younger of the two stages of Native Cat which I have examined measures in the curved condition 8 mm. greatest length, and had a head-length of 4 mm. At birth, according to Hill (3), the new-born young measures, when preserved in spirit, 5·5 mm. G.L. and 2·3 mm. H.L., so that the specimen examined would probably be 4 or 5 days old. In its general skeletal development it is slightly more advanced than is the new-born *Trichosurus*. In the head the following bones can be detected:—premaxillary, maxillary, lachrymal, jugal, squamosal, palatine, pterygoid, and mandible. In the post-cranial skeleton ossification has commenced in the scapula and in the first two ribs, while the clavicle is well ossified.

As in the Diprotodont marsupials which have been examined the early mammary fœtal *Dasyurus* has a complete shoulder-girdle, the well-developed coracoids articulating with the sternum

The plane of the girdle lies as near as may be at right angles to the axis of the cervical vertebræ. The scapula (Pl. 41. fig. 1, *sc.*) in its lower two-thirds is a narrow, somewhat flattened rod, while above it expands into a relatively rather large antero-posteriorly directed plate. From the anterior border of the scapula, at a point near the union of the lower and the middle third, a well-developed acromion process (*ac.*) arises, and passes first forwards and slightly outwards and upwards, and then downwards and inwards to meet the clavicle (*cl.*). The lower end of the scapula forms with the coracoid (*co.*) the glenoid cavity. From along the upper border of the upper part of the acromion to the anterior border of the middle third of the scapula there stretches a thin bony plate, forming the scapular spine (*sp.*).

The coracoid (*co.*), which is about half the length of the scapula, and about as wide as the scapula is in its middle region, passes inwards, a little downwards, and very slightly forwards from its point of union with the lower end of the scapula, and forms an articulation with the side of the broad presternum (fig. 2, *p.st.*), just in front of the first rib. The inner end of the coracoid is slightly dilated, and while its posterior half forms the joint with the sternum, the anterior portion passes forwards towards the clavicle, and is continued into the undifferentiated tissue which surrounds that bone.

The clavicle (*cl.*) is a well-developed little osseous bar which passes directly outwards from near the anterior end of the sternum for some distance, and then turns abruptly upwards to meet the end of the acromion. The bone is surrounded by a thick layer of undifferentiated tissue, but no cartilage can be detected in connection with it.

The sternum (*st.*) is chiefly characterized by the great breadth of its anterior part—the presternum being about three times as wide as the posterior portion. From its widest point it gradually narrows to the point of union with the fourth rib; while in the posterior half the width is moderately uniform. There is a distinct xiphisternum (*x.st.*). The sternum gives attachment to eight pairs of ribs. Anteriorly the presternum ends rather abruptly, in marked contrast to the pointed condition of the anterior end in later stages.

The omosternum is not yet formed, and is represented by a mass of undifferentiated tissue between the inner end of the clavicle and the sternum.

DASYURUS VIVERRINUS (*Later Stage*). (Pl. 41. fig. 5.)

The larger of the two stages of the mammary fœtal Dasyure which I have studied has a head-length of 8 mm. But though the fœtus is so small, development has so far advanced that in the shoulder-girdle at least practically all the features displayed are those of the adult.

The scapula (*sc.*) has a broad blade as in the adult, with a well-developed spine running down near the middle of the outer side. The change in shape of the scapula from the narrow blade of the earlier stage is brought about by the remarkable manner in which ossification takes place. In the earlier stage, the only part of the scapula that is distinctly ossified is the spine, but ossification is just starting along the surface of the cartilage in the middle region. In this later stage, all the cartilage of the scapula, except along the upper border, the acromion process, and near the glenoid cavity, has been replaced by bony tissue. The bony development, however, has not been limited to the ossification of the cartilage, but has formed a moderately large bony plate, which passes forwards from what was the anterior border of the cartilaginous scapula, and has thus converted the narrow scapula of the early stage into the broad bony blade of the later. The coracoid (*co.*) has no longer any attachment to the sternum, and with the increased size of the girdle there has become considerable alteration in shape, so that the coracoid and the acromion are now mainly directly forwards.

The clavicle is long and slender; and there is now a distinct omosternal cartilage (*o.st.*), which lies between the point of the sternum and the clavicle.

The sternum (*st.*) differs in shape from that of the earlier stage. The presternum (*p.st.*), in front of the broad part which gives articulation to the first pair of ribs, tapers away to a rather slender point.

PERAMELES OBESULA. (Pl. 41. fig. 6.)

The mammary fœtus which I have examined measured 18·2 mm. greatest length and 9 mm. head-length. At this stage, which roughly corresponds to the later *Dasyurus* stage, the coracoid has lost all connection with the sternum.

The scapula is essentially similar to that of the adult. A well-developed spine runs down near the middle of the bone, and terminates in a rather broad, flat acromion, which latter, on

passing forward, terminates in a sharp point. The "prescapula" is well developed, and here, as in *Dasyurus*, a large part of it has no pre-existing cartilaginous basis. In the figure a dotted line indicates the anterior border of the cartilaginous scapula.

The coracoid (*co.*) is small, and is directed mainly forwards from its attachment with the scapula.

The clavicle (*cl.*) is rudimentary, and has no connection, except perhaps by ligament, with either the acromion or the sternum. The rudimentary clavicle of the Bandicoot was, I believe, first discovered by Hill, who records its occurrence in his second paper on the Placentation of *Perameles* (4).

Comparative Observations.

While the shoulder-girdle of *Dasyurus* in its early stage agrees in the main with that of the Diprotodonts, it shows one or two interesting points of difference. In *Pseudochirus* we find the coracoid forming with the sternum a distinct joint, as in *Dasyurus*; but in *Trichosurus* and *Petrogale* the cartilage of the coracoid is structurally continuous with that of the sternum. And while in *Dasyurus*, as in *Pseudochirus*, the shoulder-blade becomes free by the direct separation of the coracoid from the sternum, in *Trichosurus*, at least, the separation is brought about by the degeneration of a portion of the coracoid. In the Diprotodonts, in the early stage, the coracoid from its attachment with the scapula passes mainly inwards and backwards; in *Dasyurus* it passes inwards and slightly forwards. It seems probable that though the coracoid in *Dasyurus* is less developed than in some of the Diprotodonts, it is in a much less specialized condition, more nearly approximate to that of the primitive marsupials.

If we compare the early *Dasyurus* girdle with that of the Anomodont (fig. 4), the most striking difference is seen to be due to the great reduction of the coracoidal portion of the girdle. In the Anomodont, and almost certainly in the early Theriodont from which *Dasyurus* is descended, we find the scapula fixed by a powerful coracoid (*co.*) and precoracoid (*p.co.*). In *Dasyurus* the space between the first rib and the clavicle is very short, but is almost fully occupied by the cartilage which supports the scapula. Whether this cartilage represents the coracoid or the precoracoid of the ancestor, or both, is a question which might be argued at some length. In the paper above referred to (2) I advanced some reasons for believing that it represents the

coracoid alone, and I have seen no reason to alter my opinion. The precoracoid is apparently quite lost as a cartilage, but is probably represented by the coraco-clavicular ligament.

In the previous paper on the marsupial girdle (2) it was suggested, as a possible explanation of the development of the scapula with three borders from the ancestral form which had only two, that the spine was a new formation arising from the shifting of the cleithrum from the anterior border to the outer side of the blade. Though the spine itself can hardly be regarded as the homologue of the cleithrum, it is possible that it replaces the cleithrum, and has its position determined by the pre-existing bone. The condition of the scapula in the fœtal Dasyure suggests an alternative possible explanation, as here the spine arises from the anterior border of the scapula, and the "prescapula" is a new formation. The difference in the two conditions may be due to the fact that in the Diprotodont the spine, by being to some extent on the side of the blade, leaves a distinct prescapular fossa in front; while in the Dasyure owing to the spine being attached to the anterior border of the cartilaginous blade, a prescapular fossa has to be formed by a new bony development. In the ossification of a cartilage it is exceptional for the bone to leave the limits defined by the cartilage, but another instance of it occurs in the development of the marsupial alisphenoid.

Papers referred to in the Text.

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3. Hill, J. P.—"On the Fœtal Membranes, Placentation, and Parturition of the Native Cat (*Dasyurus viverrinus*)." Anat. Anzeiger, xviii. p. 364 (1900).
4. Hill, J. P.—"Contributions to the Embryology of the Marsupials: II. On a further Stage in the Placentation of *Perameles*." Qu. Journ. Micr. Sci. vol. xliii. 1899.